Computer Technology: The Best is Yet to Come


Last year I wrote an April Fools' editorial that discussed recent computer advances at a top-secret military research facility. Since then I have talked to a number of people who read and enjoyed the editorial. Unfortunately, the "April Fool" was in the last paragraph, and a number of my readers didn't read the entire editorial. Thus, they believe that I was writing an accurate description of my visit to the research facility, rather than just writing science fiction.

Fortunately, much of what I wrote about is close enough to reality so that little damage has been done. But I have learned a lesson. No more April Fool editorials—at least for this year!

Instead, I want to write about the overwhelming pace of computer technology change that has occurred during the 30 years that I have been involved with computers, and what is likely during the next 30 years. Thirty years seems like a long time in a person's life. Thirty years ago I was newly graduated from college and first encountered a computer. It was one of those first generation vacuum tube machines; a few of its relatives still survive in museums. Thirty years from now I expect to be enjoying great grandchildren and retirement. Perhaps one of my current computers will be residing in a museum.

The past 30 years have seen truly astonishing changes in technology; the next 30 years will see much more change. Here I want to talk briefly about some of the computer-related changes and their educational implications. It was just about 30 years ago that the chip (integrated circuit) was invented. Prior to that time, a transistor was a discrete component. The first fully transistorized computers had only been available for about a year. Now a commercially available very large scale integrated circuit (VLSI) may contain a million transistors, and still denser packing of circuitry is being done in research labs. Interestingly, when adjusted for inflation, the cost of a VLSI is about the same as the cost of a single transistor 30 years ago.

The technology that has led to multimillion component chips is truly amazing, but it has its limits. Forecasts in this area suggest that current chip technology may peak out at the 100 million component level. This level will likely be reached during the next 10 years. It usually takes about five years to move a computer chip from the research laboratory into full scale, low cost production. Thus, 15 years from now one might expect to purchase a 100 million component VLSI for about the same cost (in 1989 dollars) as today's 1-million component chip.

Beyond this, further gains in chip density are difficult to forecast with confidence. There are some clever ideas being tried out in research labs. If they prove successful, further gains by another factor of 1,000 or more may be possible. But with currently available chip manufacturing technology, such gains are not possible.

You might feel that the greatest change is now past, since a factor of 1 million change has already occurred, and we are forecasting a further change by a factor of only 100. But I like to look at it in a different manner. The past 30 years have brought us reasonably decent and useful personal microcomputers. However, even the best of them aren't particularly user friendly, and they aren't very intelligent.
What lies ahead is 100 times the compute power, but for the same cost. Coupled with software progress, this means we will have personal computers that are much more user friendly and much more intelligent. Voice input and output will be common, as will access to truly huge libraries of information and programs to help process and make sense of that information.

Many of today's first graders will be finishing college just 15 years from now. They will be seeking their first jobs that require a college education. During the subsequent 15 years they will likely change jobs (indeed, careers) several times, and continue to grow in intellectual productivity. Thirty years from now they will begin to hold middle management and other leadership positions.

In these positions they will have continual access to a telecommunications system that spans the globe, databanks far more extensive than today's largest libraries, and compute power that makes most of today's computers pale to insignificance. They will routinely make use of "expert" systems that have domain specific knowledge of world class caliber.

The basic question facing our educational system is how to best educate today's students for what lies ahead. At first encounter, this seems like a difficult task. After all, how can one educate students for jobs that do not yet exist and for life in a world that will be greatly changed?

But the task is not nearly as difficult as it seems. There are many aspects of education that have enduring value. For example, knowledge of oneself, a good sense of self worth, and confidence in one's ability to cope with life in our society are all enduring qualities. Others include higher-order thinking and problem-solving skills, knowing how to learn, and knowing how to cope with change. Basic skills of speaking, listening, communicating, and interacting with others are essential now, and they will be essential 30 years from now.

Notice how few of the ideas that I have listed are directly connected to technology. Technology is a major driving force behind the changes that are going on in our society. But it is people, not technology, that are the central focus. Given appropriate help through our formal and informal educational systems, people can learn to cope with the changes that will occur.

This suggests an important dual role for computer educators. Technology is important, and we desperately need educators who easily and productively cope with technology. But these educators must be role models of human beings who are successfully coping with life in a rapidly changing, highly technological society.